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Indian Standard

CLASSIFICATION OF MUSCOVITE MICA BLOCKS, THINS AND FILMS BASED ON ELECTRICAL PROPERTIES

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(*Continued on page* 2)

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Indian Standard

CLASSIFICATION OF MUSCOVITE MICA BLOCKS, THINS AND FILMS BASED ON ELECTRICAL PROPERTIES

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 6 March 1980, after the draft finalized by the Mica Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 At present the mica trade is based on visual classification, wherein the technical suitability is being assessed on the basis of appearance. In this type of quality evaluation, emphsis is laid on clarity, colour, flatness, hardness and freedom from spots, stains, inclusions and structural imperfections. This may or may not have any bearings on the end use.

0.3 A systematic study of the properties of various grades (visual) of mica at the Central Glass and Ceramic Research Institute has corroborated the fact that most of the samples of stained and visually lower classes of mica have performance charachteristics much superior to what is generally expected on the basis of their visual appearance.

0.4 Since the best quality of mica is used in every country for making capacitors and the best criterion indicative of the suitability of a dielectric for use at radio frequencies is its power factor, the classification of mica based on power factor has been recommended.

0.5 The present classification comprises of three different grades based on the power factor range. Mica having a power factor of 0·040 percent or lower (grade E_1) is used in tuning circuits and high frequency condensers. Mica with power factor of 0·041 to 0·285 percent (grade E_2) is for general purpose application. Mica with power factor 0·286 to 2·000 percent (grade E_3) is intended for blocking condensers. Those having power factor greater than 2 percent are not suitable for use as condensers and are invariably used in domestic appliances.

0.6 For all the electrical and electronic applications of mica other electrical properties, namely, dielectric strength, dielectric constant and insulation resistance vary very little from grade to grade and even for the lower qualities (based on visual classification) the above properties are more than satisfactory. For the purpose of this classification the following electrical properties have been presumed to be applicable for all the three grades:

a) Dielectric constant	More than 6
b) Dielectric strength	More than 200 kV/mm
c) Specific resistance	More than 10^{14} ohm cm

0.7 It has not been possible so far to establish any correlation between visual classification grades as given in IS : 1175-1957* and classification based on electrical properties as given in this standard. In view of the inherent advantages of electrical classification (the test being scientific and directly related to the end use) over the visual classification (the tests are subjective and have no direct correlation with the end use) adoption of electrical classification by the mica trade is recommended.

0.8 While preparing this standard, assistance has been derived from ASTM D 748-71 (1977) 'Specification for natural block mica and mica films suitable for use in fixed mica-dielectric capacitors' issued by the American Society for Testing and Materials.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies basis for classification of muscovite mica blocks, thins and films based on electrical properties.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 1885 (Part LIII)-1980‡ shall apply.

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*Methods for grading and classification of muscovite mica blocks, thins and films.

†Rules for rounding off numerical values (*revised*).

‡Electrotechnical vocabulary: Part LIII Mica.

3. GRADING

3.1 Muscovite mica shall be classified into three grades as follows when power factor is determined at 1 MHz:

a) Grade E_1—Power factor up to and including 0.040 percent,

b) Grade E_2—Power factor between 0·041 to 0·285 percent, and

c) Grade E_3—Power factor between 0·286 to 2·000 percent.

4. METHODS OF TEST

4.1 Determination of Power Factor (Type Test) — Power factor shall be determined at 1 MHz in accordance with IS : 4486-1967* for the purpose of type tests.

4.2 Determination of Power Factor (Acceptance Test and Routine Test) — For acceptance and routine tests, the test methods shall be as given in Appendix A for determination of power factor, perpendicular to laminations; and Appendix B for determination of power factor, parallel to cleavage plane.

NOTE 1 — It has been established that the dielectric loss parallel to the cleavage plane is many times greater than that in the perpendicular direction. It would, therefore, be adequate for the purpose of this standard if the tests are carried out for power factor determination parallel to cleavage plane. However, in case of doubt or dispute, values determined by both the methods shall be within the limits of the appropriate grade mentioned in 3.1.

NOTE 2 — In case of marginal results, the test specimens shall be baked for a minimum period of 2 hours at temperature of 120°C and tested immediately upon cooling to room temperature.

4.2.1 Any other test method which would give comparable results may be used subject to agreement between the purchaser and the supplier.

4.2.2 In case of any dispute, however, the power factor shall be determined in accordance with IS : 4486-1967*.

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*Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths.

APPENDIX A

(*Clauses* 4.2, B-2.1 *and* B-3.1)

RAPID, DIRECT-READING, RESONANT-CIRCUIT METHOD FOR DETERMINING POWER FACTOR, PERPENDICULAR TO LAMINATIONS

A-1. GENERAL

A-1.1 This method contains a description of a rapid, direct-reading, resonant circuit method for measuring power factor of sheet insulating materials perpendicular to laminations at a frequency of 1 MHz. It is not intended as a precision method. Its chief virtues are the speed and simplicity with which a useful power factor indication may be obtained. No special preparation of the test specimen is necessary (other than conditioning, prior to or during testing, where necessary), such as the application of tin-foil electrodes. Likewise, no calculations are necessary.

A-2. THEORY OF OPERATION

A-2.1 This method makes use of a comparison between the maximum resonant voltage measured across a low-loss capacitor in parallel with an inductance and the maximum resonant voltage across the same circuit when a piece of block mica is introduced in series with the low-loss capacitor. To accomplish this, resonance is re-established each time a test specimen is placed in series with the low-loss capacitor by adding capacitance to duplicate the initial capacitance of the resonant circuit, by means of a variable vernier air capacitor in parallel with the coil. This provides a test method requiring but a single dial adjustment and this, combined with direct-reading meter, greatly facilitates rapid testing.

A-3. CALIBRATION

A-3.1 It is possible to calibrate the indicatings scale of the vacuum-tube voltmeter directly in terms of power factor by using test specimens of block mica of known power factor. The resulting scale then may be used to give a direct indication of power factor over a useful range. As the meter indication is a function of both the power factor and the thickness of the test specimen, the latter also shall be taken into consideration in the calibration. It has been found that if the inductance coil used in such a test circuit has a power factor value of approximately 0·003, the power factor will extend from somewhere in the vicinity of 0·0001 at full scale to about 0·02 at quarter scale of the indicating meter. It further has been found that using inductances, with power factors of 0·003 or more, the calibration is fairly independent of frequency. Even without a true power factor calibration, this method is capable of giving relative values of power factor on an arbitrary scale Where such indications are all that might be required. It has been found feasible to use an arbitrary scale in the measurement of the power factor of block mica.

A-4. TEST CIRCUIT

A-4.1 A diagram of connections of the test circuit is shown in Fig. 1.

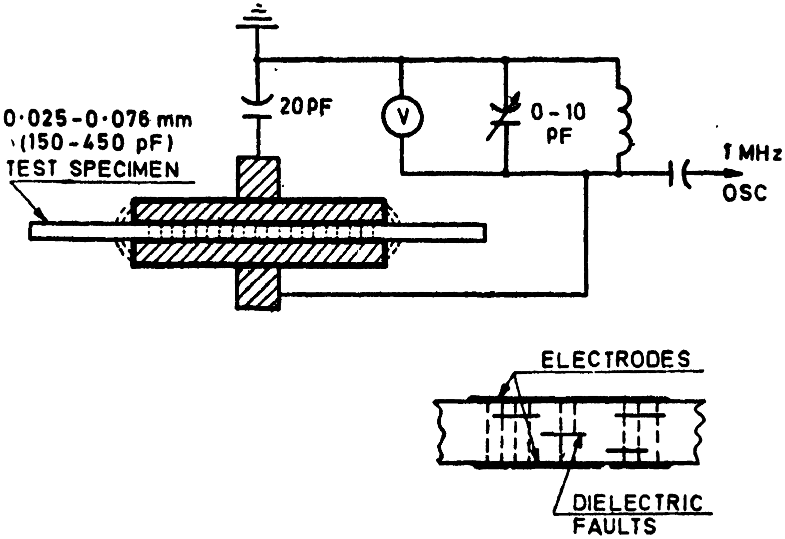

FIG. 1 SCHEMATIC ARRANGEMENT OF TEST CIRCUITS FOR POWER FACTOR DETERMINATION, PERPENDICULAR TO LAMINATIONS

A-5. SENSITIVITY

A-5.1 High sensitivity in a high power factor range is a function of low circuit power factor. To obtain this, particular care is necessary in the choice of components and insulating materials. For a test frequency of 1 MHz, a high quality conventional type variable air capacitor with a single movable plate may be used.

A-6. TEST ELECTRODES

A-6.1 The test electrodes found satisfactory for the perpendicular test method are shown in Fig. 2. These test electrodes have been designed with a view to adapting them to standard commercial testing equipment incorporating an oscillator and a vacuum-tube volt-meter.

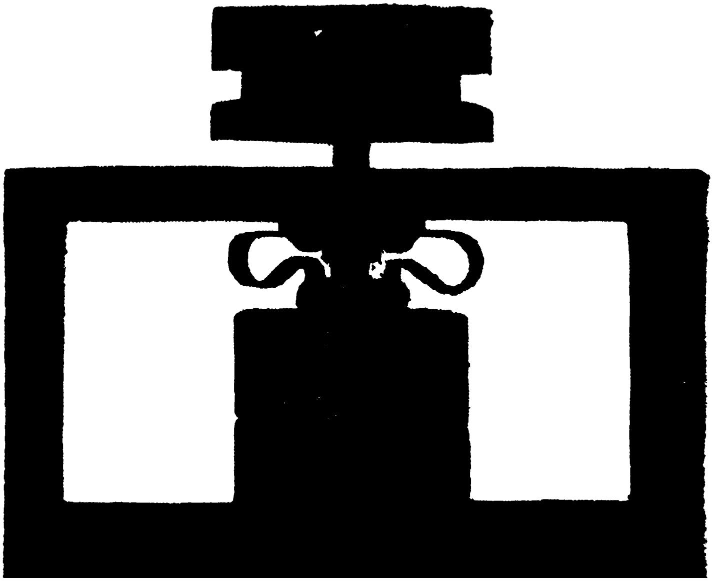

FIG. 2 TEST ELECTRODES

APPENDIX B

(*Clause* 4.2)

RAPID, DIRECT-READING. RESONANT-CIRCUIT METHOD FOR DETERMINING POWER FACTOR, PARALLEL TO CLEAVAGE PLANE

B-1. GENERAL

B-1.1 It has been established that the dielectric loss of muscovite mica is highly anisotropic. The dielectric loss parallel to the cleavage plane even in lowest loss, clear ruby mica usually is many times greater than in the perpendicular direction. The parallel loss is particularly sensitive to further degradation by non-micaceous dielectric impurities situated between the laminate such as entrapped water in internal voids of clear mica or thin plate-like semi-conducting, mineral inclusions of spotted mica. Abnormal parallel loss also results from absorbed moisture on the surface of mica but such adverse effects are practically eliminated at 1 MHz by testing in a low relative humidity of 50 percent or less.

Parallel loss is reflected in the perpendicular direction but to a lesser degree. Of significant importance is the consistent evidence that when abnormal loss is not found in the parallel direction, it does not exist in the perpendicular direction. However, the converse usually is not true. Parallel loss, therefore, appears to be more significant dielectric loss criterion of mica and due to its greater magnitude is more readily detected and measured. Abnormal parallel loss does not appear to be directly related to the amount of air inclusion as some mica containing appreciable quantities does not show abnormal parallel loss. Mica containing visible mineral inclusions, such as stains and spots, may not show abnormal parallel loss. However, the method is particularly sensitive in detecting the presence of semi-conducting stains, which increase both the parallel dielectric loss and dielectric constant. The parallel test, therefore, also is suitable for selecting stained and spotted mica for use as insulation in vacuum tubes and terminal plates where both uniform low loss and dielectric constant in the parallel direction are desirable.

B-2. THEORY OR OPERATION

B-2.1 This method employs the same test equipment as used in Appendix A except that a multiple-grid electrode with all electrode surface in the same plane is substituted for the 51-mm parallel plate electrodes of the method given in Appendix A. The grid electrode is connected in parallel with the inductance, variable air capacitor and vacuum-tube voltmeter of the resonant circuit as shown in Fig. 3. Alternate grids are connected

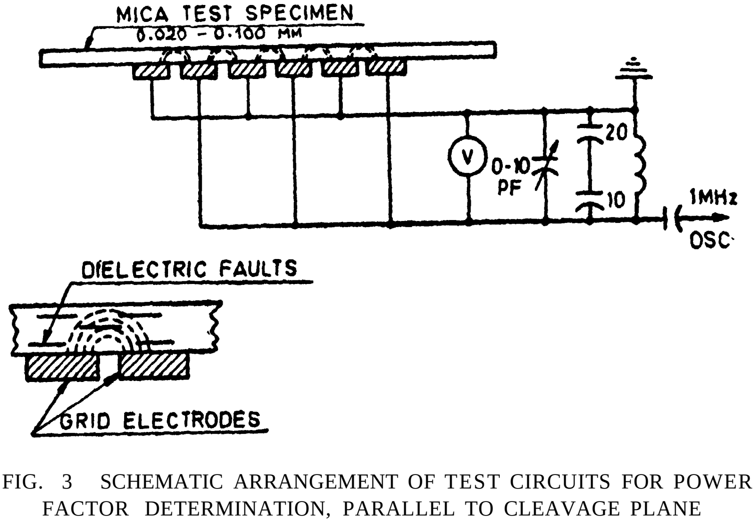

FIG. 3 SCHEMATIC ARRANGEMENT OF TEST CIRCUITS FOR POWER FACTOR DETERMINATION, PARALLEL TO CLEAVAGE PLANE

to opposite sides of the test circuit. This applies the electric field parallel to the cleavage plane of a mica specimen in contact with the grids. The resonant voltage first is adjusted to full scale, without a test specimen resting on the grid, with the vernier air capacitor set near maximum. A mica test specimen is then placed on the grid and resonance re-established by decreasing the capacitance of the vernier capacitor. The resonant voltage for the second condition is then read. The greater the deviation from the initial full-scale reading the greater the loss.

B-3. TEST ELECTRODES

B-3.1 A variety of electrode arrangements are possible for applying the electric field parallel to cleavage plane of sheet mica. An electrode which has been found suitable and which has approximately the same area as the circular 51-mm perpendicular electrodes of the method given in Appendix A is shown in Fig. 4. This grid electrode consists of 18 square metal studs 6·4 × 6·4 × 1·6 mm thick with 1·6 mm spacing between all adjacent stud edges. The circular studs are connected to the undergrounded side of the test circuit. The surfaces of the square and circular studs shall be in the same plane and ground flat, after assembly. The grounded electrodes shall be provided with centrally located 0·89 mm holes which extend from one end to the other. The threaded ends of these hollow electrode shafts shall be connected by suitable means

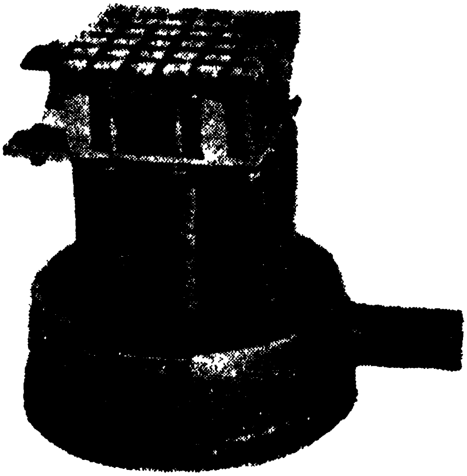

FIG. 4 GRID ELFCTRODE

to vacuum line of about 686 mm Hg, *Min.* This vacuum provides sufficient suction to flatten out curly and wavy mica films and maintain satisfactory intimate contact with the face of the grid electrode during test. The use of vacuum grip is generally recommended, particularly in cases of dispute. The total capacitance of the grid electrode assembly shall be between 15 and 17 pF. The special design features and type of insulation specified in the construction of the grid electrode automatically ensure satisfactory, low dielectric loss.

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